

# Hard Chrome Alternatives for Hydraulic Components

- Program established to assist Oklahoma City Air Logistics Center Airborne Accessories Directorate Avionics and Accessories Division (OC-ALC/LGERC) in development and implementation of replacement repair and overhaul procedures for hydraulic actuators across multiple weapon systems.



<b>Report Documentation Page</b>			Form Approved OMB No. 0704-0188	
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>				
1. REPORT DATE <b>NOV 2003</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2003 to 00-00-2003</b>		
4. TITLE AND SUBTITLE <b>Hard Chrome Alternatives for Hydraulic Components</b>			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>ARINC,2551 Riva Rd,Annapolis,MD,21401</b>			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES <b>23rd Replacement of Hard Chrome Plating Program Review Meeting, November 18-19, 2003, Cape Canaveral, FL. Sponsored by SERDP/ESTCP.</b>				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>35</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>		

# Hard Chrome Alternatives for Hydraulic Components

- Phase 1 - TO and Drawing Review, Database Development, Test Requirement Development.
  - 124 Air Force Technical Orders Reviewed.
    - 100% complete.
  - 729 Engineering Drawings Reviewed.
    - 60.4% reviewed. Remaining drawings are not available
  - 276 Chrome plated parts and 195 potentially chrome plated parts have been identified.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Flight Control Actuators.
    - 87 distinct part numbers.
    - Revised estimate: 10 will require delta-qualification.
    - Candidate items selected.



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# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility Actuators.
    - 73 distinct part numbers.
    - Revised estimate: approximately 10 will require delta-qualification.
    - 5 candidate items selected to date.
  - Snubbers.
    - 12 distinct part numbers.
    - Estimate: approximately 3 will require delta-qualification.
    - 1 candidate item selected.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Units undergoing delta-qualification
    - Flight Control: B-1 Horizontal Stabilizer
    - Flight Control: B-1 Pitch/Roll SCAS
    - Flight Control: C-130 Rudder Booster Actuator
    - Flight Control: A-10 Aileron
    - Flight Control: F-15 Pitch/Roll Channel Assembly (PRCA)
    - Utility: C-130 Ramp Actuator
    - Utility: C-135 Aileron Control Surface Snubber
    - Utility: C/KC-135 Main Landing Gear Actuator
    - Utility: C/KC-135 Main Landing Gear Door Actuator



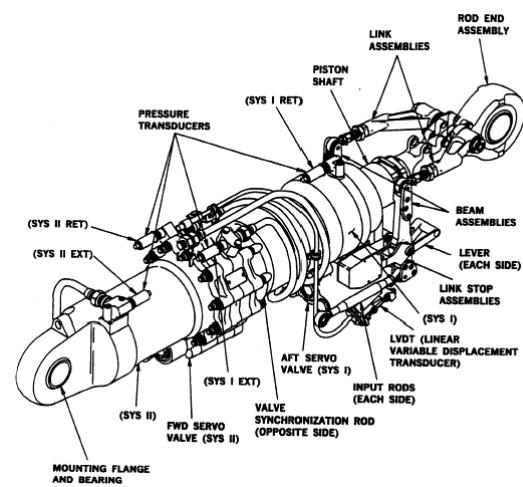
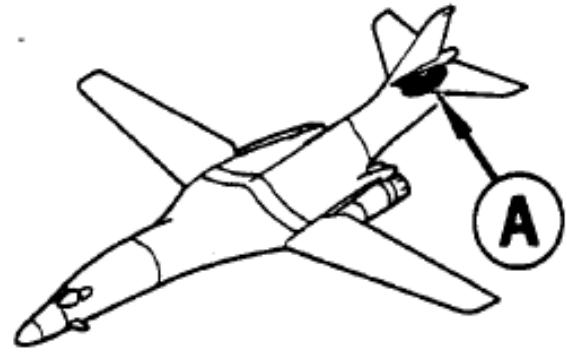
# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Planned
    - Special: KC-135 Ruddelevator
    - T-38 Aileron Actuator



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Forward piston required redesign to eliminate fatigue failures (not related to chrome)
  - Design qualification required fatigue and endurance tests
  - Opportunity to include chrome alternatives in test
  - HVOF coatings replace chrome on forward and aft pistons
  - Endurance test included - approximately 750,000 cycles
  - Results will form basis for similarity arguments for other B-1 flight control actuators



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# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
- Piston redesign completed
- Fatigue testing completed
- Endurance testing completed
- Actuator awaiting disassembly and documentation



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# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
- Numerous product improvements to be investigated
- Will include incorporation of HVOF applied coating on primary piston and new seals
- Implementation to include design layout, coating prototype, fit check, simplified endurance schedule, and similarity argument



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - C-130 Rudder Booster Assembly.
    - Rudder booster actuator delta-qualification was contracted to Kaiser Fluid Technologies (OEM).
    - In ~March 2002, Kaiser Fluid Technologies was acquired by Tactair Fluid Control.
    - Qualified by Lockheed Martin.
    - Delta-Qualification being performed by Tactair Fluid Control.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - C-130 Rudder Booster Assembly.
    - 4 chrome plated surfaces.
      - Piston rod.
        - » 3 sections, with piston heads separating them.
        - » Significant straightness issues.
      - Piston head (2 piston heads on the unit).
        - » Not part of the piston rod.
      - Trunnion OD.
        - » Mates with an aluminum-bronze bushing.
      - Trunnion ID.
        - » Not wearing part.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Rod coating surface finish and seal selection.
  - 4 Configurations being tested:
    - Electroplated Chrome with AGT seals (baseline).
    - HVOF WC-CoCr with AGT seals (new coating, baseline seals).
    - HVOF WC-CoCr with new Greene Tweed seals (new coating, cap seals).
    - HVOF WC-CoCr with new Shamban seals (new coating, cap seals).



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - A-10 Aileron Actuator (Parker)
    - Seals being selected.
    - Vibration testing cancelled.
    - Test fixture under design.
    - Redesign of piston may be required.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - F-15 Pitch/Roll Channel Assembly (PRCA)
    - ARINC is working to award work to Moog as a Government directed source.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility actuators.
    - C-130 ramp actuator.
      - Part number 370750-1.
      - Stroke: 64.998" (maximum).
      - Extended/Retracted Length: 139.6" /74.6".
      - Piston rod OD: 1.8".
      - Piston rod Material: 4340.
      - Other coatings: None.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility actuators.
    - C-130 ramp actuator.
      - Two actuators planned for delta-qualification
      - Both actuators passed ATP and are ready for testing. First actuator should be completed by end of year.
      - Replacement scraper are being tested, but with limited success. Works fine with scraper oriented up. But when oriented horizontally, scrapers are not functioning as desired.





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# Hard Chrome Alternatives for Hydraulic Components

## Phase 2 - Material, Rig, Service Testing.

- C/KC-135 main landing gear door actuator.
  - P/N: 5-84045-9.
  - Stroke: 20.66" (nominal).
  - Extended/Retracted Length: 51.66"/31.00".
  - Piston rod OD: 1.3".
  - Piston rod Material: 4340 or 4140.
  - Other coatings: Cadmium.
  - Identical to E-3 main landing gear door actuator (P/N 50-6832-10).



# Hard Chrome Alternatives for Hydraulic Components

Phase 2 - Material, Rig, Service Testing.

- C/KC-135 main landing gear door actuator.
  - Planned for disassembly in January, 2004.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility actuators.
    - C/KC-135 main landing gear actuator.
    - P/N: 5-84046-6.
    - Stroke: 13.78" (nominal).
    - Extended/Retracted Length: 44.62"/30.84".
    - Piston rod OD: 2.995".
    - Piston rod Material: AMS 6371C.
    - Other coatings: None.
    - Identical to E-3 main landing gear actuator (P/N 50-6833-9).



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility actuators.
    - C/KC-135 main landing gear actuator.
      - Units have been disassembled.
      - One unit found to be in very bad shape.
        - » Required 1300 ft-lbs to open housing.
        - » TO stated 350 ft-lbs maximum.
        - » Local shop has capability to apply up to 5500 ft-lbs torque to open housings.
      - Cleaning and inspecting components.
      - Replacing “bad” unit.





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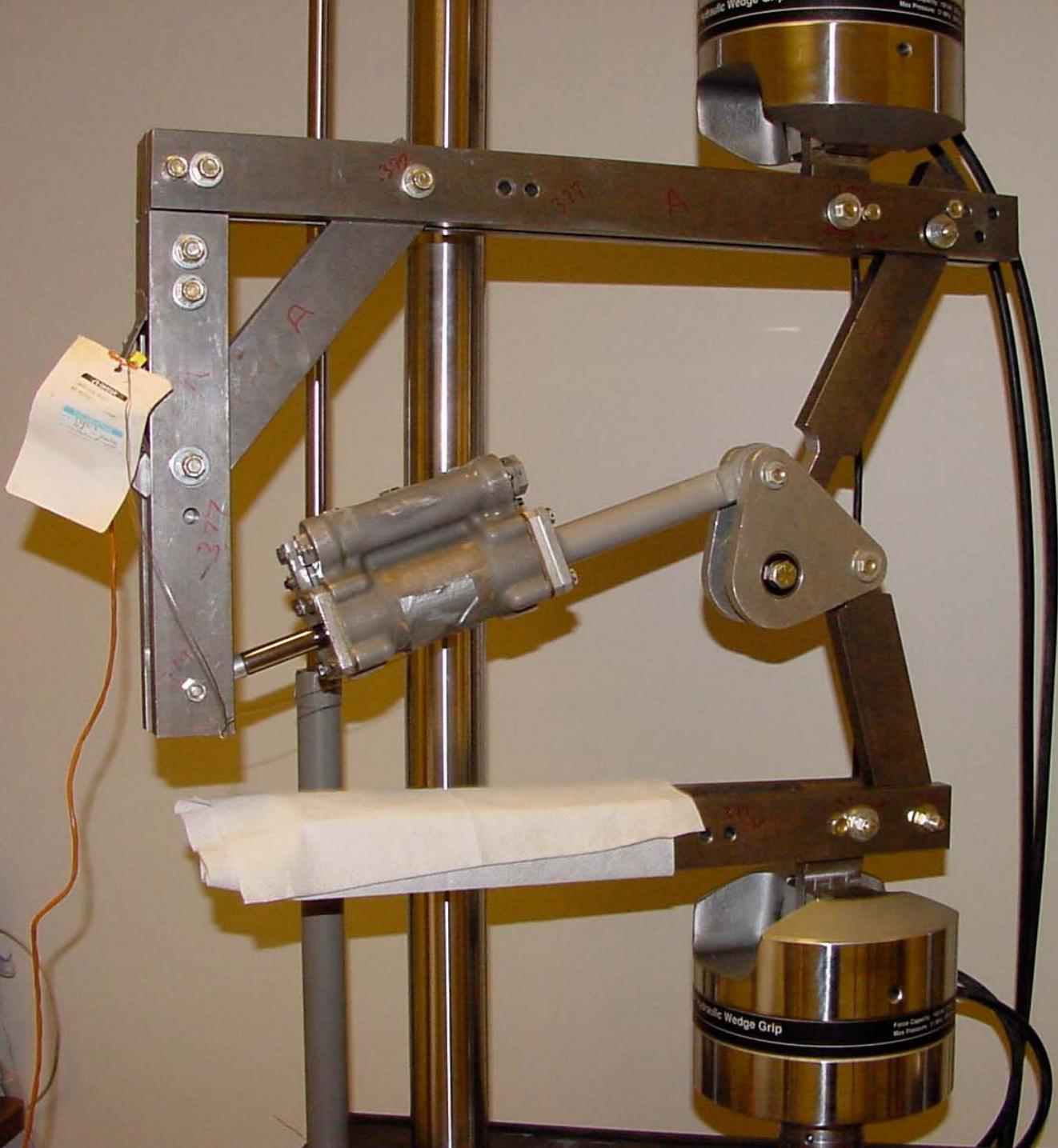
# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Utility actuators.
    - One C/KC-135 aileron snubber has been assembled and successfully passed delta-qualification testing.
    - Second C/KC-135 aileron snubber has passed cyclic testing.
    - Currently being leak tested.
    - Will be cold temperature tested after leak test.



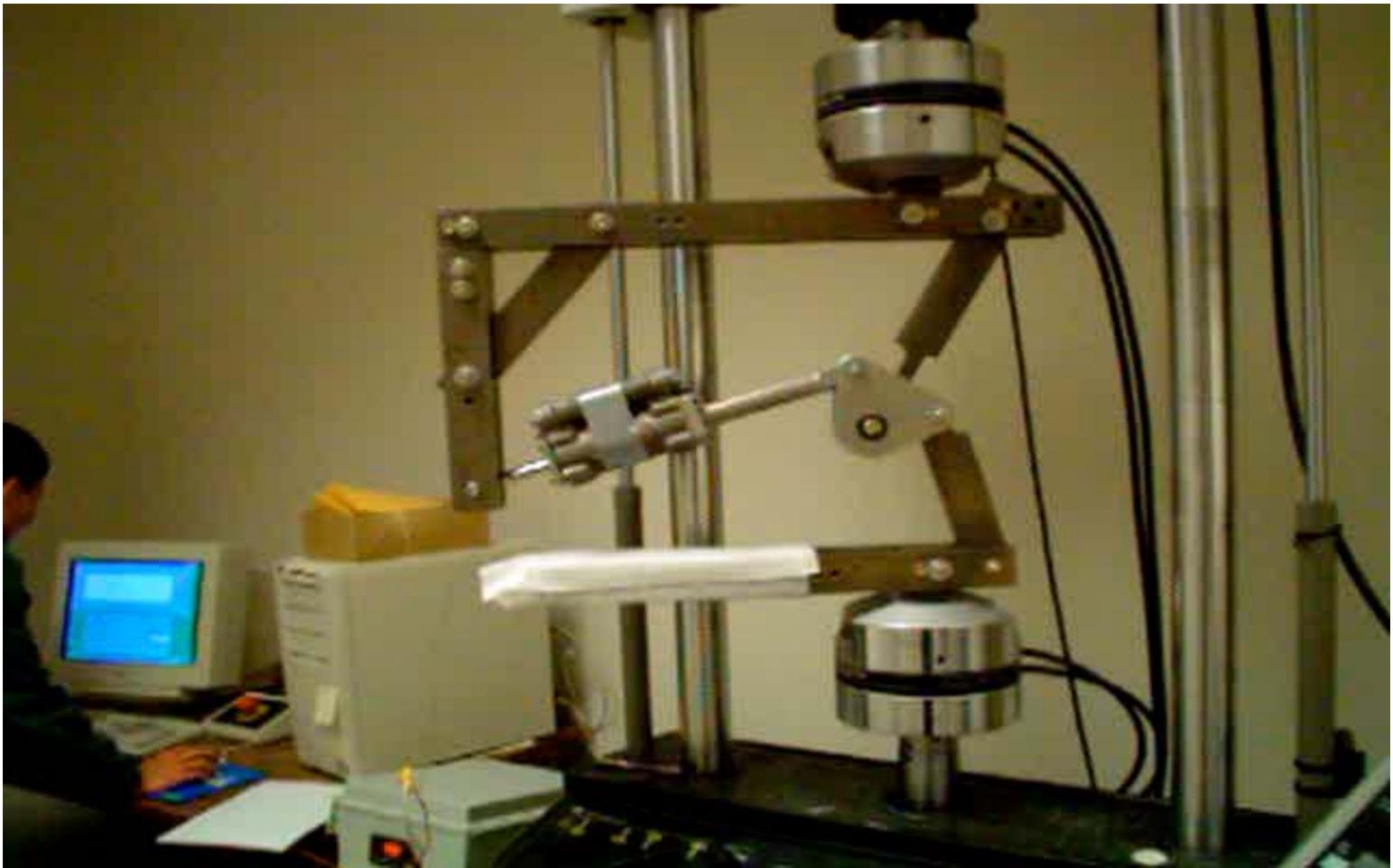


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# Hard Chrome Alternatives for Hydraulic Components



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# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Special actuator.
    - KC-135 Ruddelevator.
    - P/N: 65-6750-1.
    - Stroke: 5.875" (maximum).
    - Extended/Retracted Length: 25.580"/19.705".
    - Piston rod OD: 0.746 to 0.748".
    - Piston rod Material: 4140.
    - Other coatings: Cadmium.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Special actuator.
    - KC-135 Ruddevator.
    - Been placed on hold.
    - Cyclic testing will require 200,000 cycles. Most likely on hold until a facility capable of doing cyclic testing is located.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Service testing.
    - A 2 year service test is planned for all actuators and their similar components.
    - Example: C-130 rudder booster will be service tested concurrently with C-130 aileron and elevator actuators (based upon qualification by similarity arguments). Estimated to last two years.
    - Similar service testing planned for all other actuators.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 2 - Material, Rig, Service Testing.
  - Service testing.
    - Drafts of C-130 and C/KC-135 Service Test Plans will be ready for Government on December 1.
    - Coordination of STPs to commence as soon as STPs are released.
    - Implementation of test plans to begin as actuators complete cyclic testing.



# Hard Chrome Alternatives for Hydraulic Components

- Phase 3 - Data Evaluation
  - Results of Testing will be evaluated and a solution finalized.
    - This phase has not been reached yet.



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# Hard Chrome Alternatives for Hydraulic Components

- Phase 4 - Implementation
  - The solution developed during evaluation will be implemented.
    - This phase has not been reached yet.

